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Foraging behaviour of cattle, sheep and goats on semi-arid pastures in Kenya

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ABSTRACT

The principal aim of the study was to compare the feeding behaviour of cattle, sheep and goats on pasture and explain any differences between speices. Furthermore, I compared foraging behaviour between dry season and the beginning of the rainy season, in order to see any relationships between weather and behaviour.

The study was carried out in Shompole in southern Kenya. Behavioural data were collected by observing herds of cattle, sheep and goats on pasture. The livestock were herded on pasture during the days and kept in bomas, where people live, during the nights. The weather in Shompole is characterized by high ambient temperature and low, bimodal rainfall. However, precipitation during 2008 and 2009 was almost absent, and consequently a severe drought affected the study area.

The study was conducted from middle of December 2009 to middle of February 2010. A trained observer followed the livestock on pasture and recorded behaviour of twenty animals seven times per hour. The behaviours recorded were standing, lying, grazing, browsing, foraging fruits and seeds, ruminating, social behaviour and moving.

The study showed that goats browsed more than sheep and cattle. This is consistent with other similar studies that found that goats browse more than sheep. Morphological features of goats that contribute to their preference for browsing include their mobile upper lip and their ability to assume a bipedal stance. Results of the study showed that sheep behaved like cattle, both preferred grazing to browsing. Furthermore, goats in the present study increased their browsing over time after rainfall improved, which is contrary to other studies. Sheep, on the other hand, decreased their browsing after the rainfall improved and the vegetation improved.

I concluded that goats in Shompole browsed more than cattle and sheep. Goats increased their browsing as forage improved while sheep on the other hand decreased their browsing as vegetation improved.

SAMMANFATTNING

Studien syftade primärt till att jämföra födobeteende hos nötkreatur, får och getter på bete och förklara eventuella skillnader. Vidare jämförde jag födosöksbeteende mellan torrsäsong och början av regnsäsong, för att se samband mellan väder och beteende.

Studien genomfördes i Shompole i södra Kenya. Beteendedata samlades in genom observation av flockar av nötkreatur, får och getter på bete. Boskapen vallades på bete på dagarna och hölls i befolkningens bosättningar på nätterna. Vädret i Shompole karaktäriseras av en hög temperatur och låg nederbörd uppdelat på två regnperioder. Dock uteblev nederbörden nästan fullständigt under 2008 och 2009, varför en allvarlig torka påverkade studieområdet.

Studien genomfördes från mitten av december 2009 till mitten av februari 2010. En utbildad observatör följde boskapen på bete och noterade sju gånger i timmen beteendet hos tjugo djur i flocken. De beteenden som noterades var stå, ligga, beta gräs, beta buskar, äta frukter och frön, idissla, socialt beteende samt rörelse.

Getter betade av buskar mer än vad får och nötkreatur gjorde. Detta överensstämmer med liknande studier som visade att getter äter buskar mer än får. Morfologiska egenskaper hos getter som bidrar till deras preferens för buskar är bland annat deras rörliga överläpp samt deras förmåga att stå på två ben. Resultaten av studien visade att får beter sig som boskap, båda föredrar att beta gräs framför att beta av buskar. Vidare betade getterna i den aktuella studien mer av buskar över tiden efter att nederbörden ökade, vilket är motsatsen till resultat i andra studier. Får å andra sidan betande mindre av buskar efter regnet ökade och även tillgång till markvegetation ökade.

Jag drog slutsatsen att getter i Shompole betade mer av buskar än nötkreatur och får. Getter betade mer av buskar när betet förbättrades medan får betade mindre av buskar när vegetationen förbättrades.

INTRODUCTION

Kenya has a population of around 38 million people (www.ne.se), of which in the years 2004-2006 around 30% were undernourished (www.wfp.org). The climate varies from arid to semi-arid in the northern and eastern parts of the country to tropical along the coast. In the world's arid and semi-arid lands pastoralism is considered as the most important and sustainable livelihood system (Butt, 2010), approximately half of the world's pastoralists are found in Africa (Degen, 2007). In Kenya pastoralists occupy about 70% of the total land area.

Pastoralism

Pastoral societies are defined generally as societies that raise livestock under extensive conditions using natural pasture as the main forage for the animals (Degen, 2007). The animals supply the owners with milk, meat, wool/hair, leather and dung. Generally do pastoralists depend on seasonal rainfall for sufficient forage. This seasonal rainfall is one of the main factors influencing herding strategies (Butt, 2009). During the wet season when the availability of forage resources increase, herders are thought to respond to this by utilizing an energy-conserving strategy; keeping cattle as close to the settlement as possible (Coppolillo, 2000). This strategy increases forage intake and reduces the amount of labour required for herding. During the dry season when forage resources are likely to decrease, herders direct cattle to available forage further from the settlement.

Livestock

Pastoralists often shepherd several species of livestock consequently the rangeland can be better utilized (Degen, 2007). However, the traditional pastoral society in Africa relied almost exclusively on cattle and only a few household kept small livestock (Solomon et al., 1991).

The indigenous cattle population in Kenya is called Small and Large East African Shorthorn Zebu (*Bos indicus*), constituting 77% of the total cattle population in Kenya (Rege et al., 2001). *B. indicus* are able to survive and reproduce under the harsh climatic, nutritional and managerial conditions that characterize arid and semi-arid lands like Kenya.

Most pastoral societies include goats and sheep. They are generally low-producing in terms of milk and offspring, but well-adapted to the climate and are relatively tolerant to local diseases (Degen, 2007). In Africa, goats and sheep have become more important in the livestock herded by pastoralists (Degen, 2007). Among the Maasai cattle has become less numerous while the numbers of sheep and goats have increased, mainly to lessen the risk of livestock loss due to drought and diseases (Degen, 2007).

Digestion in ruminants

Cattle, sheep and goats are all ruminants (Dyce et al., 2002). The digestion in ruminants is characterized by their four stomachs three of which are fore-stomachs (rumen, reticulum, omasum) (Sjaastad et al., 2003). The fore-stomachs contain microorganisms that cause an anaerobic degradation of nutrients, the so called fermentation. The microorganisms in the fore-stomachs are able to break

bonds in cellulose and hemicellulose, substances which are important in the diet of the ruminant. When the ingesta have passed through the three fore-stomachs it enters the abomasums, which is equal to the stomach in simple stomached species. Fermentation in the fore-stomachs produces a variety of end products which then are absorbed from the digestive tract and utilized by the animal. Fermentation of fibre-containing feeds is time consuming. Consecutively, for ruminant digestion to be efficient a long retention time of fibrous food is necessary, this is partly accomplished by rumination (Radostits et al., 2007). When the animal ruminates, the content from the fore-stomachs is transported back to the oral cavity for additional chewing. Rumination allows further breakdown of feed with the addition of large quantities of saliva. This process is a unique characteristic of ruminants.

Behaviour on pasture

In fragile ecosystems it is important to understand diet selection and behaviour of ruminants on natural pasture, in order to maintain an eco-friendly management strategy as well as a profitable animal production (Sanon et al., 2007). Cattle, sheep and goats differ when it comes to browsing and grazing. Sheep and cattle are mainly grazers (Degen, 2007), while goats are considered to browse to a higher degree (Ouéndraogo-Koné et al., 2006).

Comparing the behaviour of animals on pasture in rainy and dry season can yield a number of differences, although some studies show different result. According to Sanon et al. (2007) cattle, sheep and goat show a decrease in feeding activities from rainy season to dry season. Sheep and goat increased their browsing activity in the dry season while cattle browsed around the same amount all the study period. On the other hand, Ouédrago-Koné et al. (2006) showed that sheep, goats and cattle browsed to the same extent during the dry season.

Drought

The study started in extreme climate conditions; in 2008 rainfall was poor in Kenya and in 2009 the long rains failed over most of Kenya (Western, 2009). As a result the drought in 2009 was a tragedy for millions of farmers and herders, millions of cattle died countrywide. By October 2009 more than half a million people had left their homes in the rangelands of Kenya, searching for forage. By the end of 2009 and early 2010 the precipitation improved in Kenya (www.wfp.org). However, due to poor or failed rains since 2007 the recovery process in Kenya is slow.

Aim of the study

The aim of the study was to compare foraging behaviour of cattle, sheep and goats on semi-arid pastures, and to discuss any differences from an anatomical and physiological point of view. Furthermore, the objective of the thesis was to compare the feeding behaviour between dry season and the beginning of the rainy season, to find relationships between weather and the behaviour of cattle, sheep and goats on pasture.

MATERIALS AND METHODS

Study Area

The study was conducted in Shompole, Kajiado district in Rift Valley, southern Kenya. The region is characterized by high ambient temperature and low, bimodal rainfall (Morris et al., 2009) with short rains from October to December and long rains from March to May (Solomon et al., 1991). Mean annual rainfall varies from 300 to 800 mm. The habitat types in Kajiado include shrub grasslands, open grasslands, plains, open woodlands and swamps (Morris et al., 2009). Main grass species that dominate most areas in Rift Valley are kikuyu grass, star grass, couch grass and wire grass (Lukuyu et al., 2009) and the dominant tree species in Rift Valley are Acacia spp. (Agassiz and Harper, 2009).

People in Shompole live in bomas, i.e. settlements that consist of six to twelve dwellings surrounded by a protective enclosure (Morris et al., 2009). The settlements with people and livestock move between different areas in Shompole, depending on rainy or dry season.

The study site was selected for a variety of reasons, like being representative as a typical area for pastoral societies. A prerequisite to conduct research in this area is the presence of the African Conservation Centre (ACC) via its conservation program in the area. ACC is a non-profit Non-Governmental Organization which selects key landscapes to undertake projects that would have broad application, with the aim to conserve wildlife and the natural environment in East Africa (www.conservationafrica.org).

In 1998, the ranch community in Shompole reserved a 10,000 ha wildlife sanctuary for tourism (Moris et al., 2009). In 2002 ACC began establishing conservation areas in Shompole (www.conservationafrica.org). Aided by ACC, the Shompole community struck a shareholder agreement with a tour operator to build and manage a tourist lodge (Moris et al., 2009). The wildlife sanctuary and tourist lodge generate income for the community.

Animals and management system

During evening and night the animals in Shompole are kept in the boma, i.e. the place where the people and livestock live. Cattle are kept within the circle of huts and sheep and goats within the inner enclosure. During daytime the animals are herded on natural pastures.

Goats and sheep are herded together on pasture while cattle are kept by another herder. During the time of my study, the herder took the livestock out for grazing twice daily. They left the boma early in the morning at 6 a.m. and returned at 9 a.m. to the boma for milking. The second grazing period was between 11 a.m. and 5 p.m. In the evening the animals were milked once more. If the pasture was poor close to the boma the herder took the animals further away already in the morning and stayed out until evening.

The cattle were of an indigenous breed, Small and Large East African Shorthorn Zebu (*Bos indicus*). The cattle herds consisted of cows, heifers, bulls, steers and calves. The sheep were of an indigenous fat-tailed breed and goats were of an

unknown indigenous breed. Both male and female goats and sheep of different ages were kept together.

Data collection

The data in the study were collected by observation by two educated local Masaai. They had been trained by another Masaai who had previously performed a similar study in Masai Mara.

The data were recorded during 65 observation days, from mid December 2009 to mid February 2010.

Six different herds were observed and behavioural data were recorded. The observer recorded data from different species on different days. The selected herds contained cows, sheep and goats, with at least twenty animals of different sex and age of every species. The selected bomas should not be situated too far away from the observer's home.

In the morning on an observation day the observer started a stopwatch just before the herd left the boma. Seven times per hour the behaviour of twenty randomly selected livestock from the herd was recorded instantaneously as scan sampling. He recorded behavioural data on minutes 0:00, 0:05, 0:10, 0:20, 0:30, 0:40 and 0:50 in each hour. The recorded behaviours were standing, laying, grazing, browsing, foraging fruits and seeds, ruminating, social behaviour and moving as described in Tab 1.

Table 1: Behaviour definitions

Behaviour	Description
Standing	Animal standing, without performing any other visible activity
Lying	Animal lying, without performing any other visible activity.
Grazing	Animal standing or walking in grass with its head in a downward position.
Browsing	Animal standing or walking with its head in trees or shrubs
Social behaviour	Two individuals of the same or different species interacting, for example mating, fighting, licking or nursing.
Ruminating	Animal chewing without any visible foodstuff in the mouth both when lying, standing and moving.
Foraging fruits and seeds	Animal standing or walking under a tree with its head in a downward position. Fruit or seeds have to be seen by the observer.
Movement	Animal walking or running, without performing any other visible activity like social behaviour or foraging.

Table 2: Precipitation during the study period (13 December 2009 – 16 February 2010). There was almost no rainfall during the months previous to the study.

Week	Amount of precipitation (mm)
1	12
2	45
3	59
4	20
5	5
6	0
7	0
8	20
9	0

Data analysis

The collected behavioural data were compiled in Microsoft Excel and Minitab program Version 15 was used to perform the analysis. Since the data were not normally distributed (as found with Anderson-Darling test), they were analyzed with the non-parametric Kruskal-Wallis test. To increase the quality of the data analyzed, observation hours with less than four observations were excluded from the data set. All results are presented as mean ± SE.

In the graphs showing behaviour over time (Fig. 2-4), the behaviour "resting" includes standing, lying and ruminating, the behaviour "browsing" includes browsing and foraging fruits and seeds on the ground and the behaviour "moving" includes moving and social behaviour. The observation period for sheep and goats was divided into three periods, each constituting three weeks. The observation period for cattle was also divided into three periods but in this case period one consists of three weeks while the following two periods consist of two weeks each, because of fewer observation weeks for cattle.

RESULTS

Total observed behaviour

Goats browsed more than cattle ($P < 0.001$) and sheep ($P < 0.001$) but grazed less than cattle ($P < 0.001$) and sheep ($P < 0.001$). Fruits and seeds were more consumed by goats compared to cattle ($P < 0.001$) and sheep ($P = 0.004$). There were no differences between species regarding the frequencies of standing, lying, social behaviour, moving and ruminating.

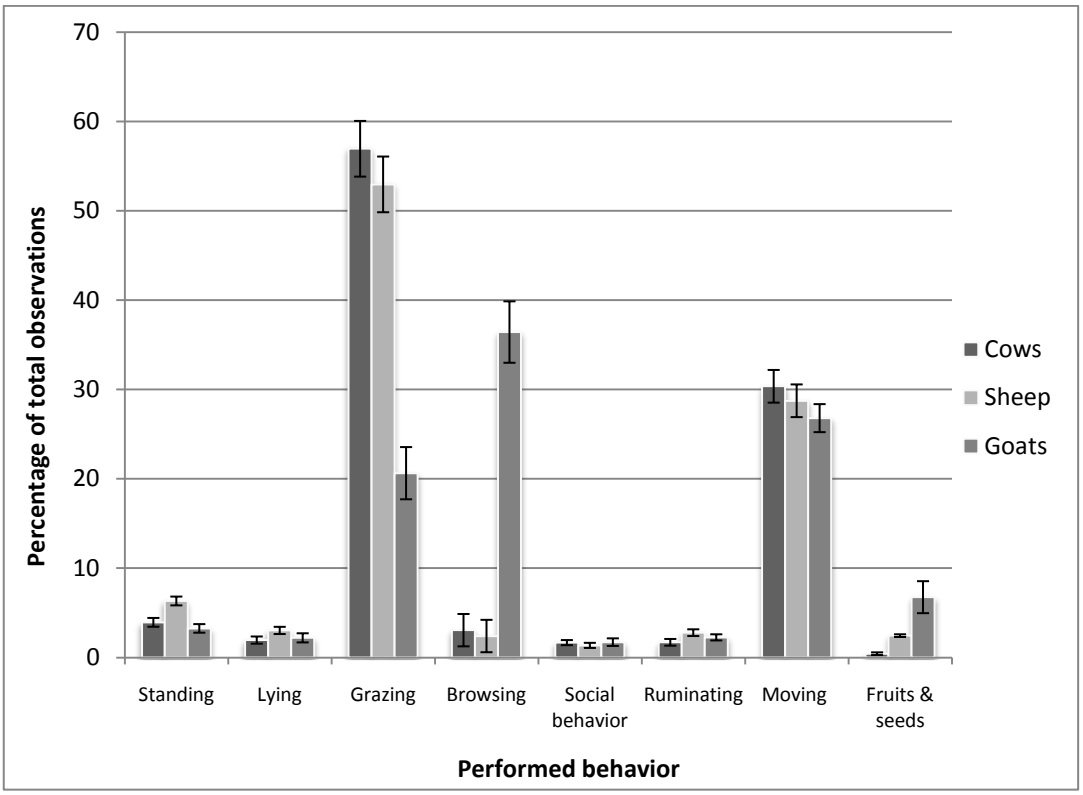

Figure 1: Percentage of performed behaviours (mean ± SE) by cattle, sheep and goats during the entire observation time. N = 22 observation days for cows, N = 22 observation days for sheep, N = 21 observation days for goats.

Behaviour over time goats

Goats increased their browsing over time (P = 0.009, Fig. 2). The frequencies of grazing, moving and resting did not change over the time of the study (Fig. 2).

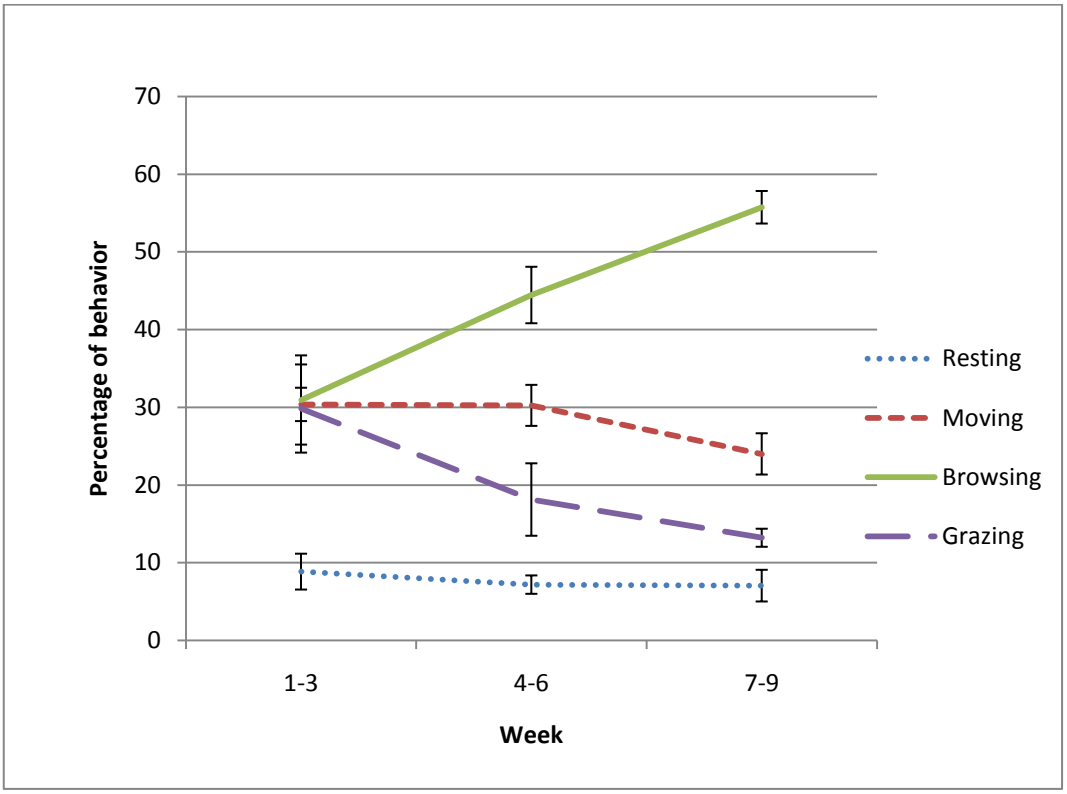

Figure 2: Percentage of performed behaviour (mean ± SE) by goats over time. The observation time is divided into three periods, each consisting of three weeks. Week 1-3: 13 December 2009 – 3 January 2010 (N =7 observation days), week 4-6: 4 January 2010 – 25 January 2010 (N = 8), week 7-9: 26 January 2010 – 16 February 2010 (N = 6).

Behaviour over time sheep

Sheep decreased their browsing during week 4-6 compared to the other weeks, (P = 0.04, Fig. 3). No other differences in behaviours over time were found.

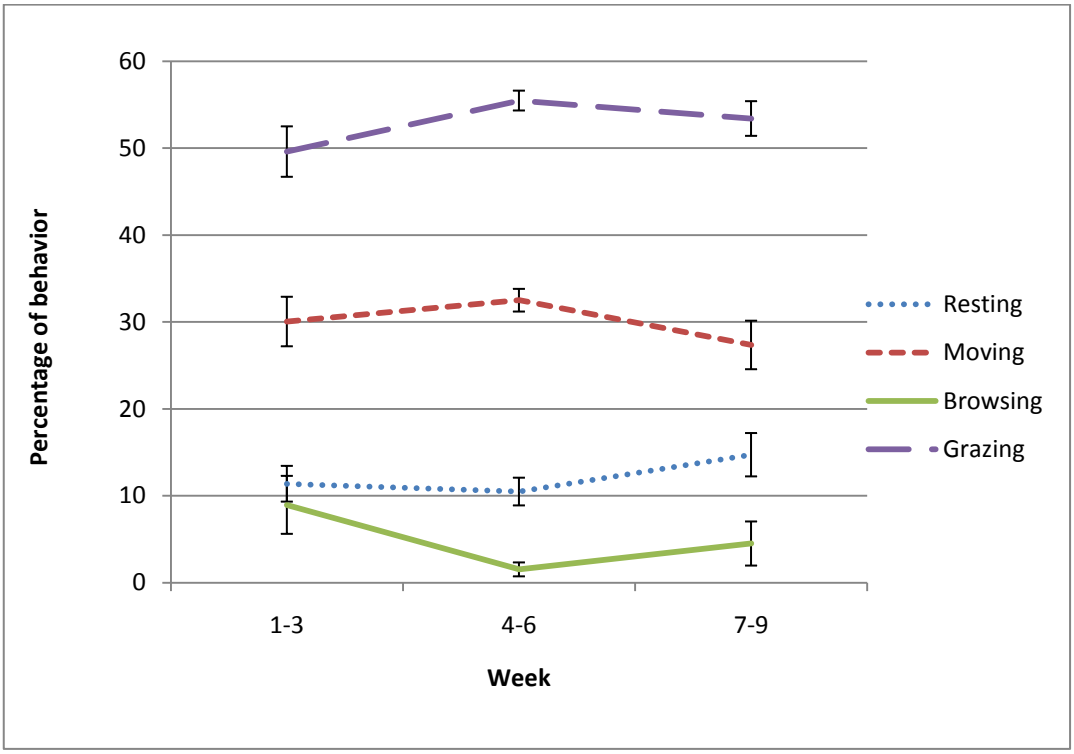

Figure 3: Percentage of performed behaviour (mean ± SE) by sheep over time. The observation time is divided into three periods, each consisting of three weeks. Week 1-3: 13 December 2009 – 3 January 2010 (N =7 observation days), week 4-6: 4 January 2010 – 25 January 2010 (N = 8), week 7-9: 26 January 2010 – 16 February 2010 (N = 6).

Behaviour over time cattle

In cattle, there were no differences in any behaviour over time.

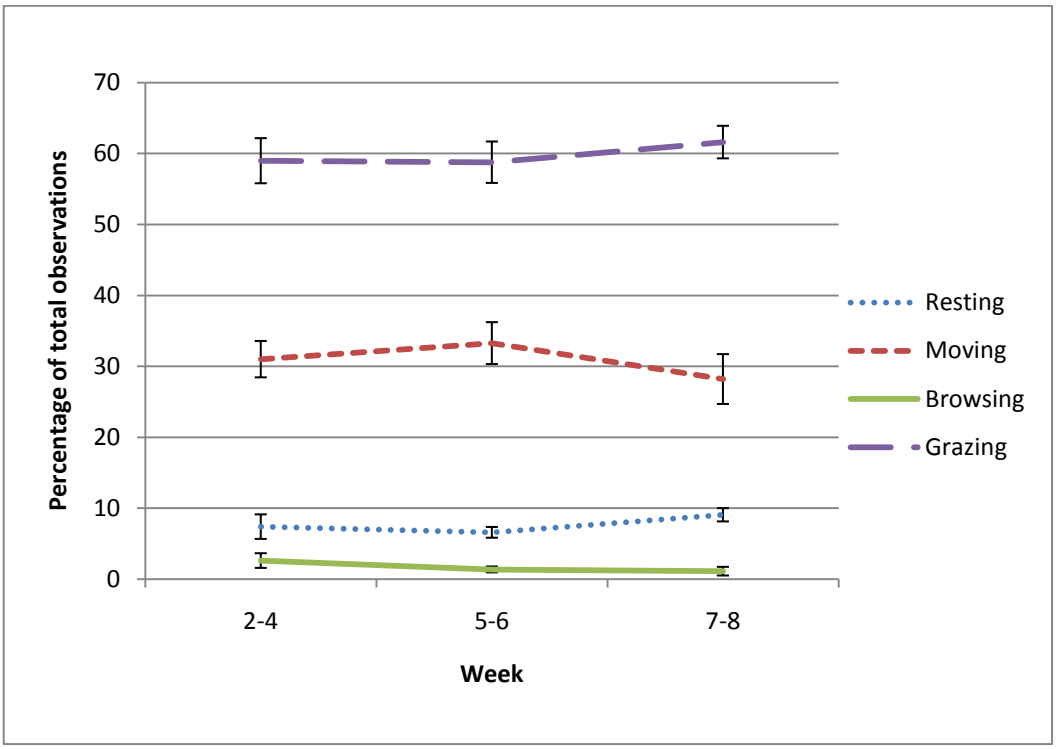

Figure 4: Percentage of performed behaviour (mean ± SE) by cattle over time. The observation time is divided into three periods, period one consisted of three weeks while the following two periods consisted of two weeks each. Week 2-4 :21 December 2009 – 9 January 2010 (N=7 observation days), week 5-6: 10 January 2010 – 24 January 2010 (N=8), week 7-8: 25 January 2010 – 6 February 2010 (N=7).

DISCUSSION

Browsing versus grazing

The present study shows that the activities of the animals vary according to animal species. The most prominent difference was that goats browsed significantly more than sheep and cattle and grazed consequently less than sheep and cattle. This is in conformity with other similar studies, for example Rutagweda et al. (1990), who showed that cattle and sheep preferred grass while consumption of grass by goats was much lower. Also Ngwa et al. (2000) showed that goats differ fundamentally from sheep in their feeding habits; e.g. spent goats around 75% of their feeding time browsing whereas sheep grazed 75% of their time on pasture.

The browsing habits of goats could be due to several morphological features, which allow the goat to be a successful browser (Ngwa et al., 2000). For example the goat has a mobile upper lip which lacks the dividing philtrum of the sheep (Smith and Sherman, 2009). This feature favors the grasping and tearing, actions central to browsing. The philtrum in the sheep, on the other hand, favors consumption of grasses close to the ground. Furthermore, goats have a greater tolerance for bitter taste than cattle and sheep, which allows for a wider range of plant species to browse.

Another key morphological feature of goats is their ability to assume a bipedal stance when feeding, which makes it possible for goats to browse at a mean height of 1.65 m (Sanon et al., 2007). In comparison cattle only reaches the height of 1.47 m and sheep browse even lower (0.87 m). The ability of the goat to forage overhead is particularly important during the dry season when little forage is to be found on the ground. However, according to Sanon et al. (2007), when there is shortage of feed resources all species browse.

In 1973 Hofmann did a classic work on ruminants where he examined the foraging preferences of groups of ruminants in relation to their digestive anatomy (Robbins et al., 1995). He postulated that difference in the carbohydrate composition of grasses and browse requires different strategies for optimal digestion, resulting in the evolution of dissimilarity in alimentary tract morphology between browsing and grazing animals (Hofmann, 1989). Hofmann classified ruminants in to three distinct feeding types based on morphological observations of the digestive system, its supporting structures and other organs (Clauss and Lechner-Doll, 2001). The three groups he used were “grass and roughage eaters” (GR), “intermediate feeders” (IM) and “concentrate selectors” (CS). GR, the group which cattle and sheep belong to, are characterized by their adaption to forage rich in structural carbohydrates (cellulose) i.e. fibrous food (Hofmann, 1989). CS are adapted to process easily digestible forage rich in solubles, while animals in the IM group choose a mixed diet but avoid fibers as much as possible. Goats belong to the IM group (Hofmann, 1989).

According to Hofmann (1989) CS differs from GR in their digestive tract. For example GR have shorter lips and a smaller mouth opening compared to CS. The smaller mouth opening in species such as cattle and sheep helps prevent grass losses during grazing. Furthermore, the epithelial lining of the mouth cavity and the tongue is thinner and less cornified in CS and IM compared with GR.

Consequently the mouth of GR is better protected against grass and roughage (Hofmann, 1989).

Hofmann theorized that grazing ruminants are better adapted to consuming slowly digested plant fibers (typically grass) than are browsing ruminants (Robbins et al., 1995). He based this on the fact that grazers have a larger rumen and that the structure of the rumen and omasum makes the passage of food proceed more slowly to the lower tract, which enables them to process the structural carbohydrates in grass. Browsers, on the other hand, have smaller and less complex rumens and omasums. In addition their larger salivary glands produce a profuse amount of saliva to help buffer the rapidly digestible diet and aid in the passage of foods from the rumen. This makes them more suited for feed with high levels of cell solubles.

However, in the last two decades scientists have begun to propose that many of Hoffmans's physiological and nutritional explanations are not supportable. For example suggest Gordon and Illius (1994) that African ruminants with different feeding habits show little difference in their digestive function. They argue that the differences in digestive function associated with the consumption of grass or browse are primarily the result of the body size of the animal and not from variation in the anatomy of the alimentary tract.

In conclusion, it is well known that goats browse more than sheep and cattle, especially during the rainy season (Ouéndraogo-Koné et al., 2006). However, I believe these differences have not been fully explained. Some scientists relate the differences completely to morphological features, like the anatomy of the alimentary tract. Others argue that these differences can be related to the body size of the animal. However, some of the characteristics of goats, like their ability to assume a bipedal stance and their mobile upper lip, strike me as crucial reasons as to why goats browse to a larger degree than cattle and sheep.

Rumination

In my study did cattle, sheep and goats ruminate to a very low degree on pasture. On average they only spent about 1.5-3% of their time on pasture ruminating. This is not in conformity with Sjaastad et al. (2003) where ruminants spent one third of their lifetime ruminating. In Bayer's study from 1990 cattle rested, including rumination, about 5% of the herding day. Bayer (1990) proposed that the low frequency of resting and rumination was due to the ability of cattle, with limited access to grazing during the day, to postpone rumination until night. This is a possible explanation to the low frequency of rumination in this study.

Variations over time

In fall 2009 Shompole received very small amounts of precipitation, which led to a dry climate with a shortage of vegetation. However, in the end of December 2009 and beginning of January 2010 (week 2-3 of the study, see Tab 2) it rained almost every day; some days up to 20 mm. According to Ngwa et al. (2000) grass grows very rapidly following the arrival of rain, hence I conclude that the vegetation were of high quality in the second period (04/01/2010 – 25/01/ 2010).

The most prominent variation in behaviour over time was that goats increased their browsing frequency. This means that the goats in the present study increased their browsing as the vegetation, most likely, improved; this is in contrast to other studies like Sanon et al. (2007). Sanon et al. (2007) showed that the time goats spent browsing increased in the dry season when the forage resources declined. The results in the present study may be explained by the fact that the behaviour "browsing" includes both browsing leaves and foraging fruits and seeds. In some of the days at the end of the observation period, fruits and seeds contributed in a high degree to "browsing". For example, 25/01/2010 23% of the 57% browsing consisted of foraging fruits and seeds. According to Animut et al. (2008) goats are known for their consumption of seeds, they are also adept at obtaining fruits through the use of bipedal stance.

The result also show that sheep browse less in period two (week 4-6) compared to the other periods. The lesser browsing of sheep in the second period is in conformity with my assumption that vegetation improved in that period. As previously mentioned sheep are grazers (Animut and Goetsch, 2008), but with limited availability of grass sheep can be efficient browsers (Valderrabano et al., 1996). The result is consistent with other studies like Omphile et al. (2004) who showed that sheep depend on herbaceous forage during the wet season and browse more in the dry season.

The temperature was quite consistent during the data collection period (middle of December 2009 to middle of February 2010). The mean of the daily maximum temperature for the first period: 34.2ºC, second: 32.5ºC and third: 37.5ºC. According to the inhabitants of Shompole a temperature drop related to rainfall is often observed. The drop in temperature increases the livestock's sensibility to diseases like pneumonia. However, in the present study, no temperature drop was registered in connection to the precipitation in the end of December 2009 and beginning of January 2010.

A well known dilemma is that livestock is prone to diarrhea, which in some cases lead to fatalities, when they gain access to fresh grass after a period of drought (Jens Jung, personal communication). This can be explained by that after a period of drought when the rain arrives livestock suddenly gain access to high-energy forage. As mentioned before dose grasses grow very rapidly after rainfall causing a rapid increase in the plant biomass (Ngwa et al., 2000). This fast transition from almost no forage to high-energy forage affects the microorganisms in the rumen (Radostits et al., 2007). There is a marked change in the microbial population and an increased production of lactic acid. The lactic acid will cause a drop in ruminal pH and in severe cases, even the blood pH falls. The livestock will show signs of anorexia, depression, ruminal stasis, profuse diarrhea, dehydration and severely affected animals may die (Radostits et al., 2007).

Why do pastoralists keep different types of livestock?

Pastoralists inhabit land where the potential for crop cultivation and conventional farming is limited or not possible because of low and highly variable rainfall conditions, harsh landscape or extreme temperatures (IFAD, 2009). Therefore, pastoralists keep livestock adapted to the environment and use natural rangeland as the main forage (Degen, 2007). Different species of livestock fulfill different

functions and for this reason pastoralist often keep a diversity of species (Anderson, 2003). Another reason for keeping more than one species of livestock is that the risk of losing livestock are more evenly distributed , whether losses are due to disease or extreme environmental conditions (Solomon et al., 1991).

Disasters like drought are always a threat to the Maasai and they are also subjected to various uncertainties due to economic and political forces beyond their control (Solomon et al., 1991). Although cattle are less likely to survive a drought than smallstock they are more valuable in terms of both money and milk supply therefore the Maasai keep them to accumulate long term security. Maasai people tend to accumulate livestock to be "wealthy". Moreover, cattle are kept by pastoralists mainly for milk production, but they are also used as gifts and as draftpower. Their dung is used for different purposes like fertilizer, fuel and building material (Rege et al., 2001). Cattle are only slaughtered at special occasions, such as weddings, funerals and religious festivals (Solomon et al., 1991). Furthermore, cattle generate cash income by exchanging them for cash.

In Kenya *Bos indicus* (zebu cattle) is the most common cattle species (Rege et al., 2001). Mwacharo (2006) showed that the reasons why pastoralists choose to keep zebu cattle are their disease resistance, drought and heat tolerance and their feed and water requirements. *Bos indicus* is adapted to temperate environments and compared to *Bos taurus* they have a greater sweating rate due to high density of sweat glands, quick transfer of metabolic heat to the skin and less hair coat (Behl et al., 2010). Another way in which the zebu cattle (*Bos indicus*) have adapted to the harsh climate is that they reduce their maintenance requirements in response to food shortage (Western and Finch, 1986). This favors prolonged productivity, slows weight loss, increases survival and prolongs meat and milk production. Western and Finch, (1986) showed that the practice of Massai in drought, to walk cattle greater distances, water them less frequent in order to graze further away, imposed little energetic cost to their zebu cattle. By watering cattle less frequently, the herder can lead the animals to more distant but better pasture.

It has also been shown that Bos indicus carry lower burden of the cattle tick *Boophilus microplus* (Chan et al., 2010). Although they give less milk than *Bos taurus*, their production is far less sensitive to food deficiency and recovers sooner following droughts. As a result, *Bos indicus'* adaptive features such as feeding behaviour, disease and heat control enable them to cope effectively with a variety of stressful tropical environments (Mwacharo et al., 2006).

According to Degen (2007), Maasai in East Africa are known for their cattle raising. However, they hold more sheep and goats than they do cattle. Sheep and goats are especially import during drought when they provide crucial food, especially by providing meat. Furthermore smallstock are very important in post-drought recovery as their survival rates are higher, they reproduce more rapidly and goats provide milk much sooner after a drought than cattle (Solemon et al., 1991). All in all, sheep and goats are mainly kept for meat. Because of their low value compared to cattle and the convenient amount of meat they provide, most animals slaughtered by choice are sheep and goats.

CONCLUSIONS

From the results of the study I conclude that goats on natural pasture in Shompole browsed more than cattle and sheep. However, goats unexpectedly increased their browsing as forage improved. Sheep on the other hand decreased their browsing as vegetation improved which is in compliance with their categorization as grazers. Further studies regarding the behaviour of livestock on natural pasture are desirable in order to reach valuable conclusions on how to optimize Maasai herd management.

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